Prentice Hall

EARTH SCIENCE

Tarbuck ◆ Lutgens

Chapter 19

Air Pressure and Wind

19.1 Understanding Air Pressure

Air Pressure Defined

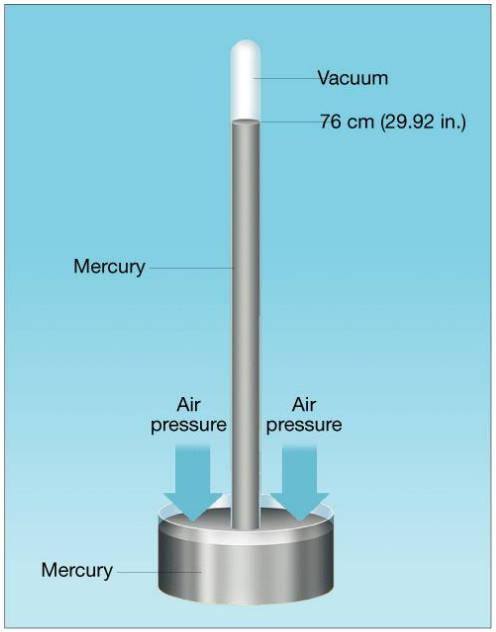
- **Air pressure** is the pressure exerted by the weight of air.
- Air pressure is exerted in all directions—down, up, and sideways. The air pressure pushing down on an object exactly balances the air pressure pushing up on the object.

19.1 Understanding Air Pressure

Measuring Air Pressure

- A **barometer** is a device used for measuring air pressure.
- When air pressure increases, the mercury in the tube rises. When air pressure decreases, so does the height of the mercury column.

A Mercury Barometer



19.1 Understanding Air Pressure

Factors Affecting Wind

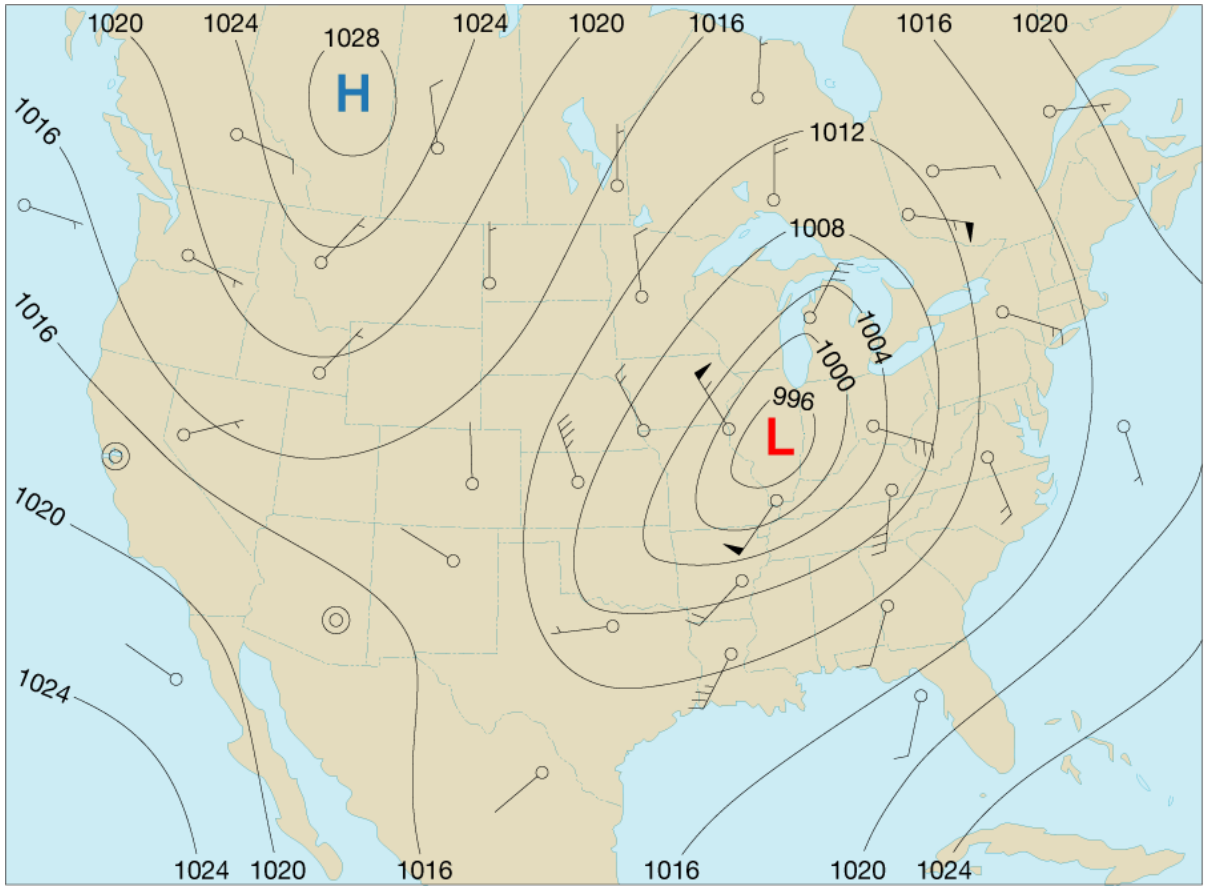
- Wind is the result of horizontal differences in air pressure. Air flows from areas of higher pressure to areas of lower pressure.
- The unequal heating of Earth's surface generates pressure differences. Solar radiation is the ultimate energy source for most wind.
- Three factors combine to control wind: pressure differences, the Coriolis effect, and friction.

19.1 Understanding Air Pressure

Factors Affecting Wind

- Pressure Differences
  - A **pressure gradient** is the amount of pressure change occurring over a given distance.
  - Closely spaced isobars—lines on a map that connect places of equal air pressure—indicate a steep pressure gradient and high winds. Widely spaced isobars indicate a weak pressure gradient and light winds.

Isobars



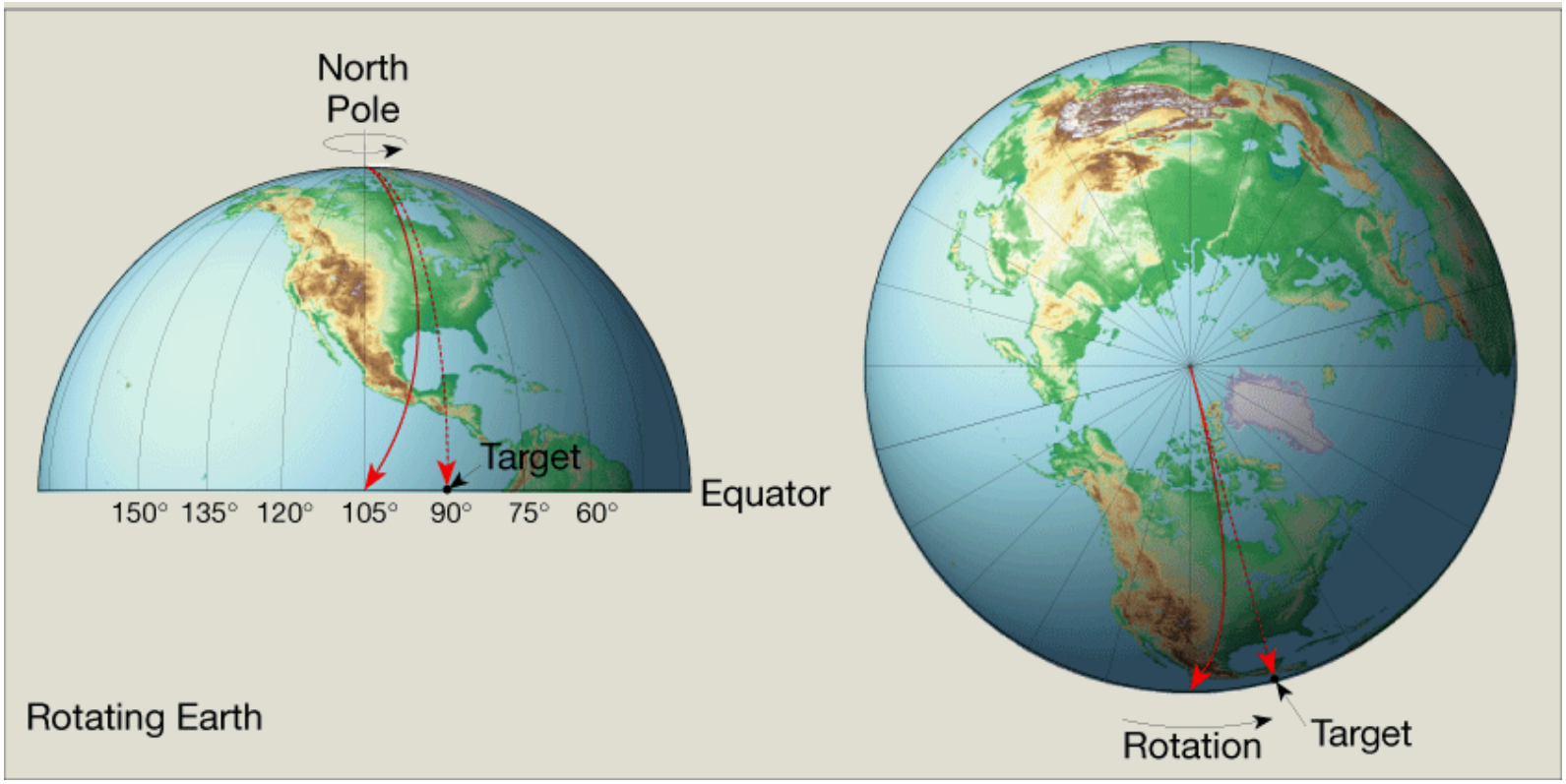
ff	Miles per hour
◎	Calm
	1–2
	3–8
	9–14
	15–20
	21–25
	26–31
	32–37
	38–43
	44–49
	50–54
	55–60
	61–66
	67–71
	72–77
	78–83
	84–89
	119–123

19.1 Understanding Air Pressure

Factors Affecting Wind

- Coriolis Effect
  - The **Coriolis effect** describes how Earth's rotation affects moving objects. In the Northern Hemisphere, all free-moving objects or fluids, including the wind, are deflected to the right of their path of motion. In the Southern Hemisphere, they are deflected to the left.

The Coriolis Effect

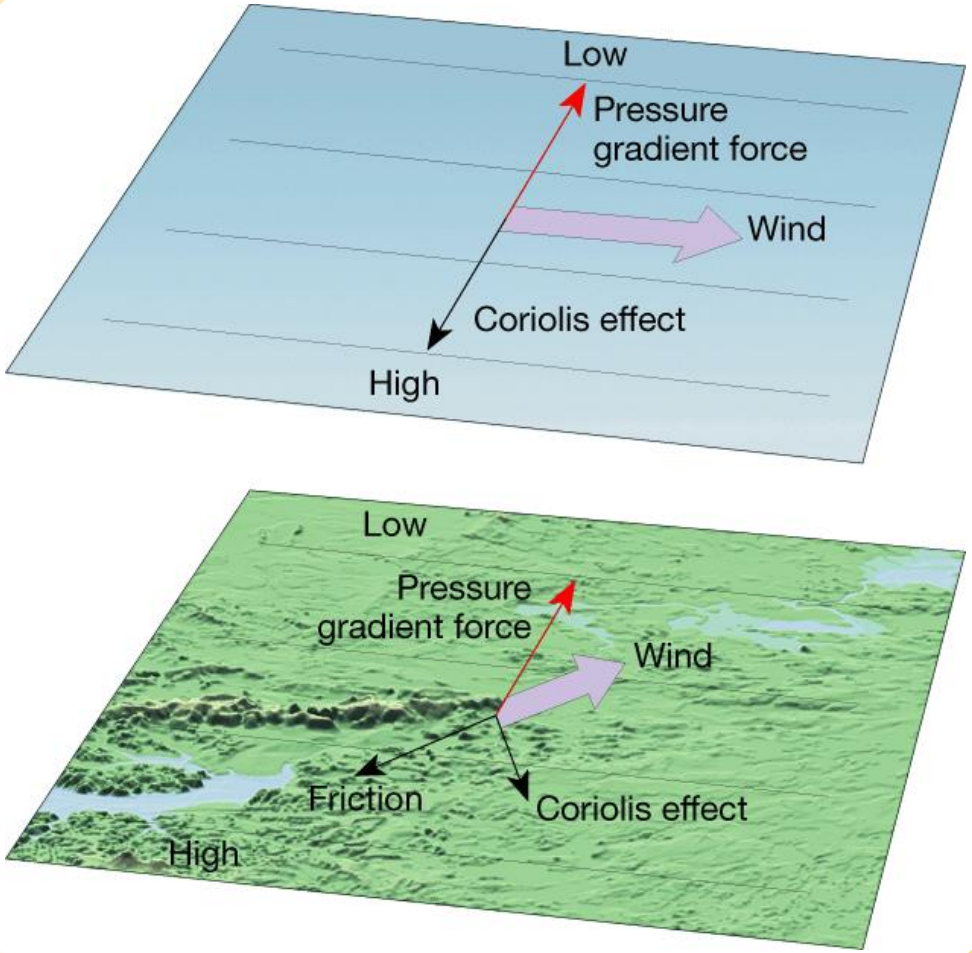


19.1 Understanding Air Pressure

Factors Affecting Wind

- Friction
  - Friction acts to slow air movement, which changes wind direction.
  - **Jet streams** are fast-moving rivers of air that travel between 120 and 240 kilometers per hour in a west-to-east direction.

Effect of Friction



19.2 Pressure Centers and Winds

Highs and Lows

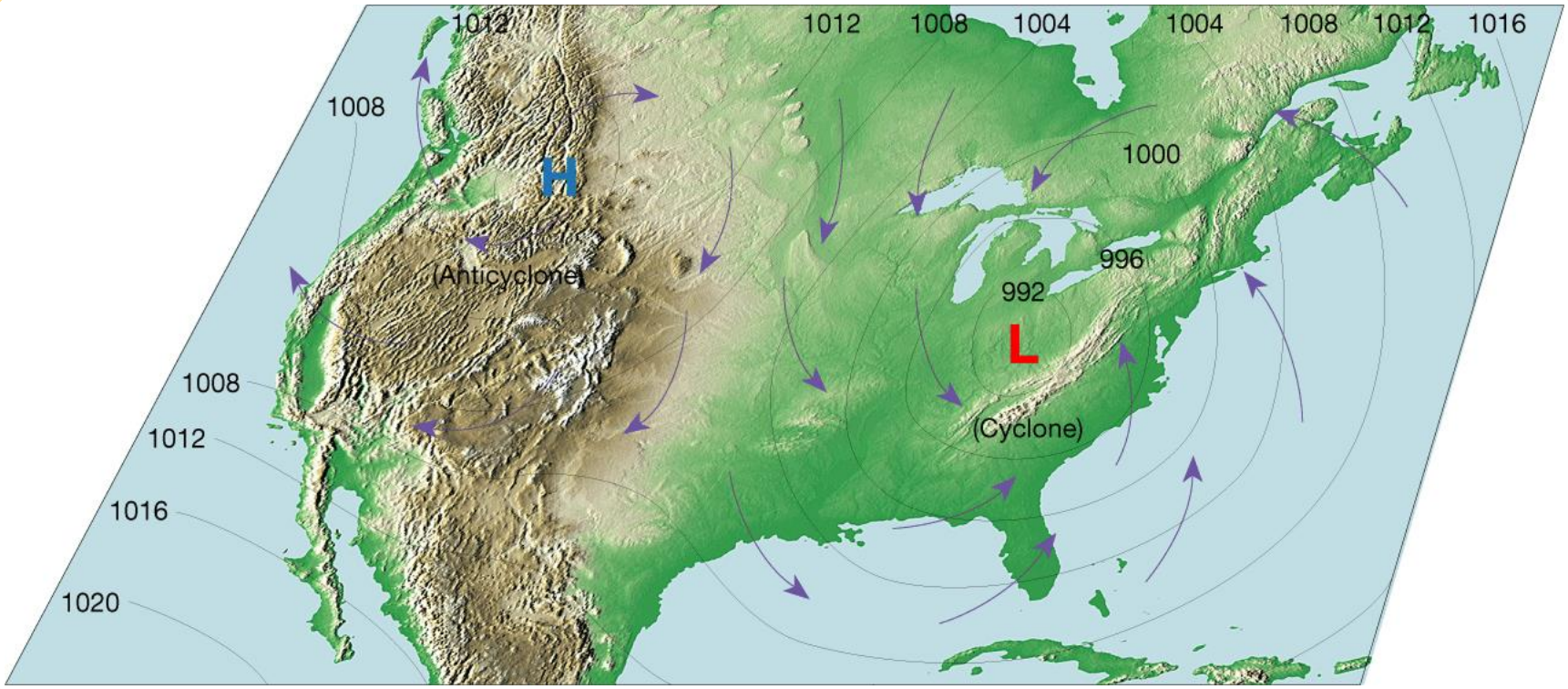
- **Cyclones** are centers of low pressure.
- **Anticyclones** are centers of high pressure.
- In cyclones, the pressure decreases from the outer isobars toward the center. In anticyclones, just the opposite is the case—the values of the isobars increase from the outside toward the center.

19.2 Pressure Centers and Winds

Highs and Lows

- Cyclonic and Anticyclonic Winds
  - When the pressure gradient and the Coriolis effect are applied to pressure centers in the Northern Hemisphere, winds blow counterclockwise around a low. Around a high, they blow clockwise.
  - In either hemisphere, friction causes a net flow of air inward around a cyclone and a net flow of air outward around an anticyclone.

Cyclonic and Anticyclonic Winds

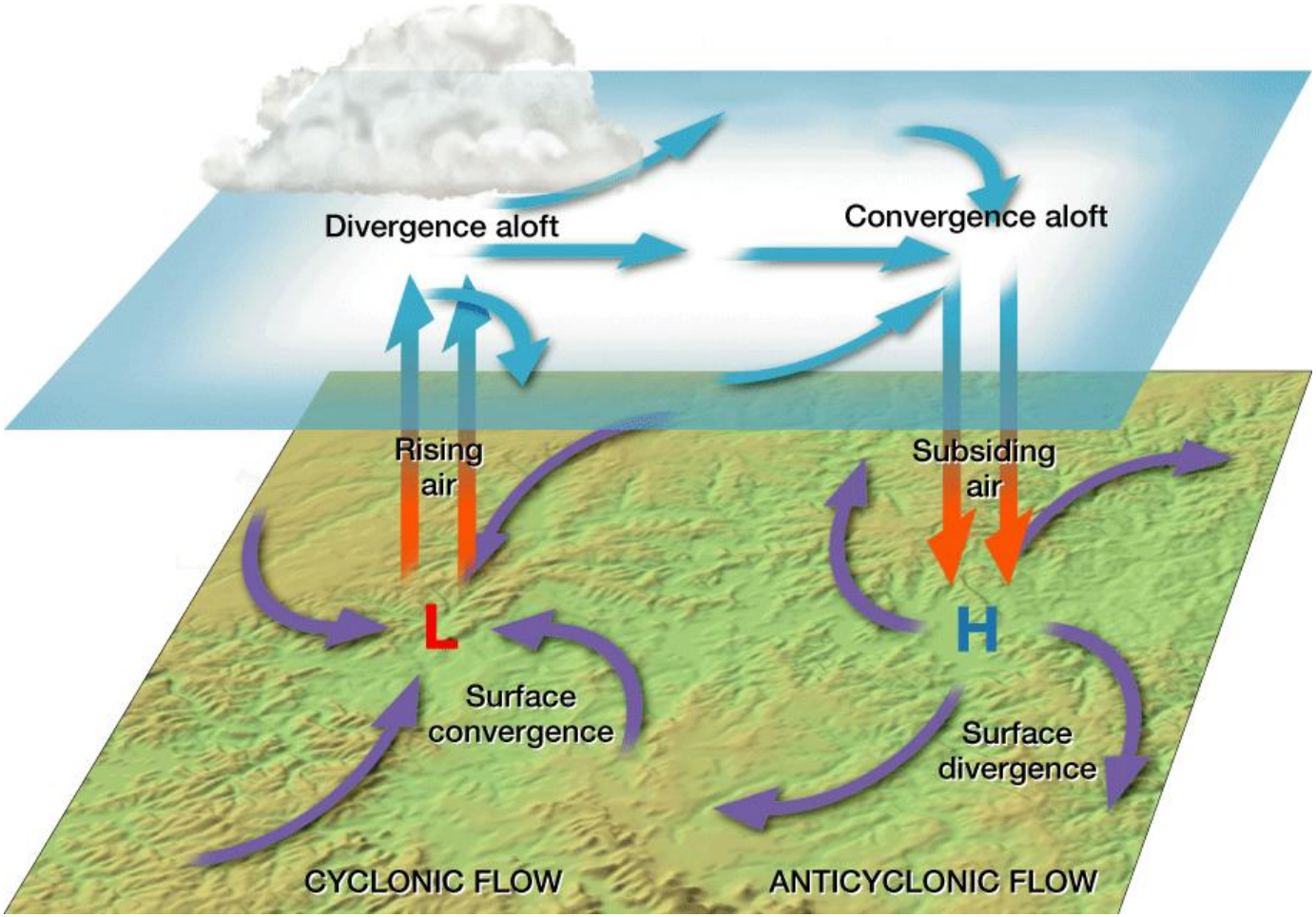


19.2 Pressure Centers and Winds

Highs and Lows

- Weather and Air Pressure
  - Rising air is associated with cloud formation and precipitation, whereas sinking air produces clear skies.
- Weather Forecasting
  - Weather reports emphasize the locations and possible paths of cyclones and anticyclones.
  - Low-pressure centers can produce bad weather in any season.

Airflow Patterns, Surface and Aloft



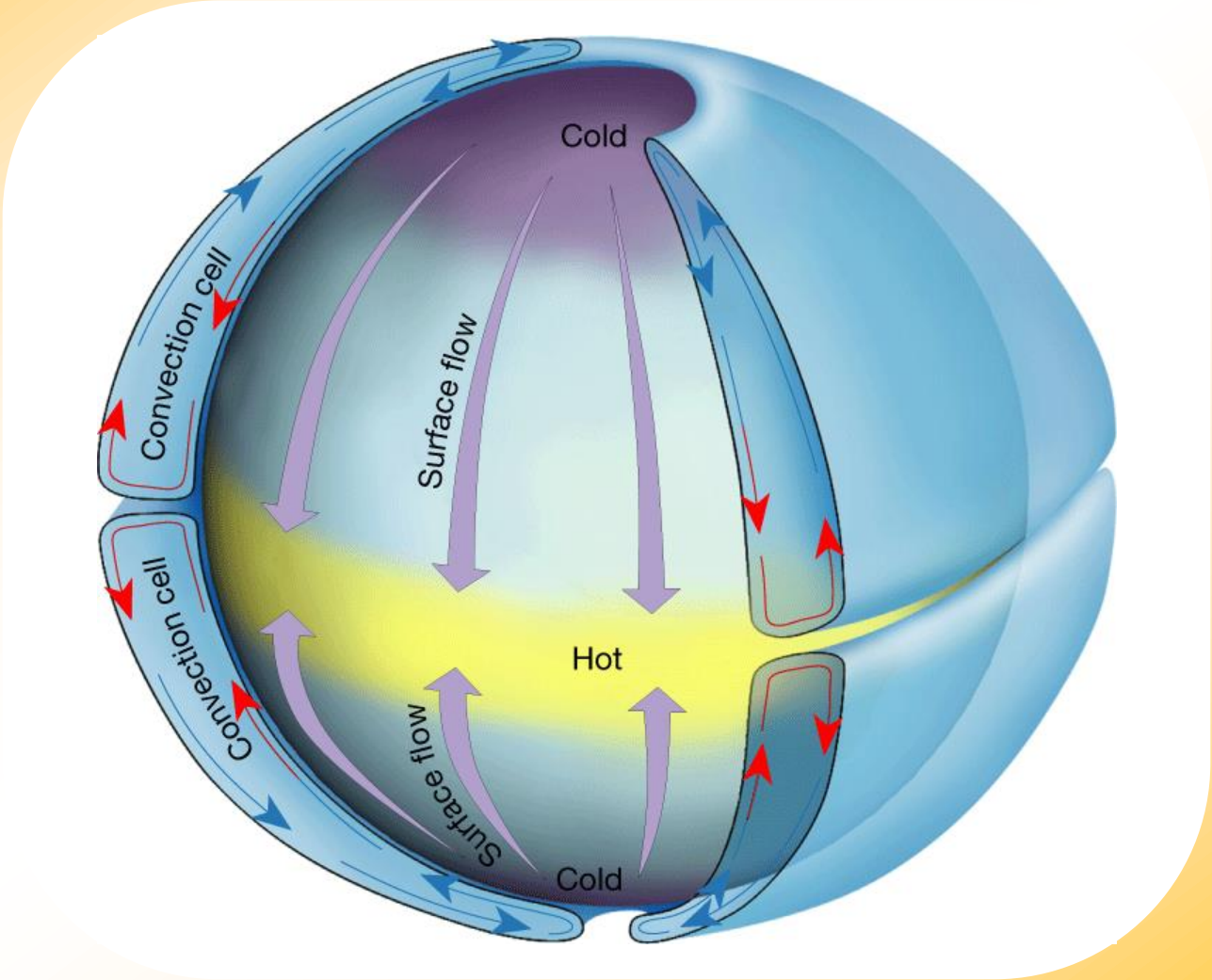
19.2 Pressure Centers and Winds

Global Winds

- The atmosphere balances these differences by acting as a giant heat-transfer system. This system moves warm air toward high latitudes and cool air toward the equator.

- Non-Rotating Earth Model
  - On a hypothetical non-rotating planet with a smooth surface of either all land or all water, two large thermally produced cells would form.

Circulation on a Non-Rotating Earth



19.2 Pressure Centers and Winds

Global Winds

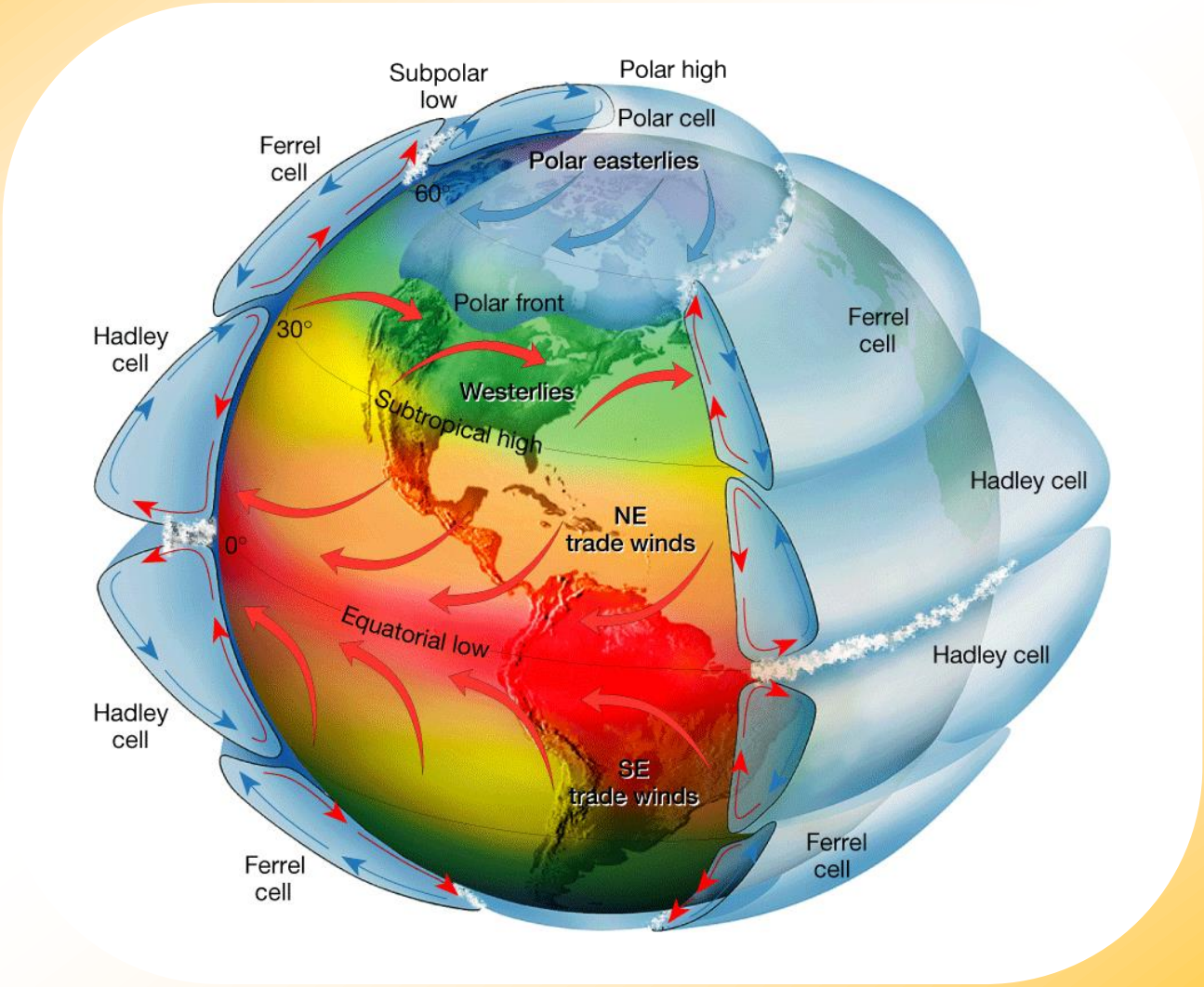
- Rotating Earth Model
  - If the effect of rotation were added to the global circulation model, the two-cell convection system would break down into smaller cells.
  - **Trade winds** are two belts of winds that blow almost constantly from easterly directions and are located on the north and south sides of the subtropical highs.
  - **Westerlies** are the dominant west-to-east motion of the atmosphere that characterizes the regions on the poleward side of the subtropical highs.

19.2 Pressure Centers and Winds

Global Winds

- Rotating Earth Model
  - **Polar easterlies** are winds that blow from the polar high toward the subpolar low. These winds are not constant like the trade winds.
  - A **polar front** is a stormy frontal zone separating cold air masses of polar origin from warm air masses of tropical origin.

Circulation on a Rotating Earth

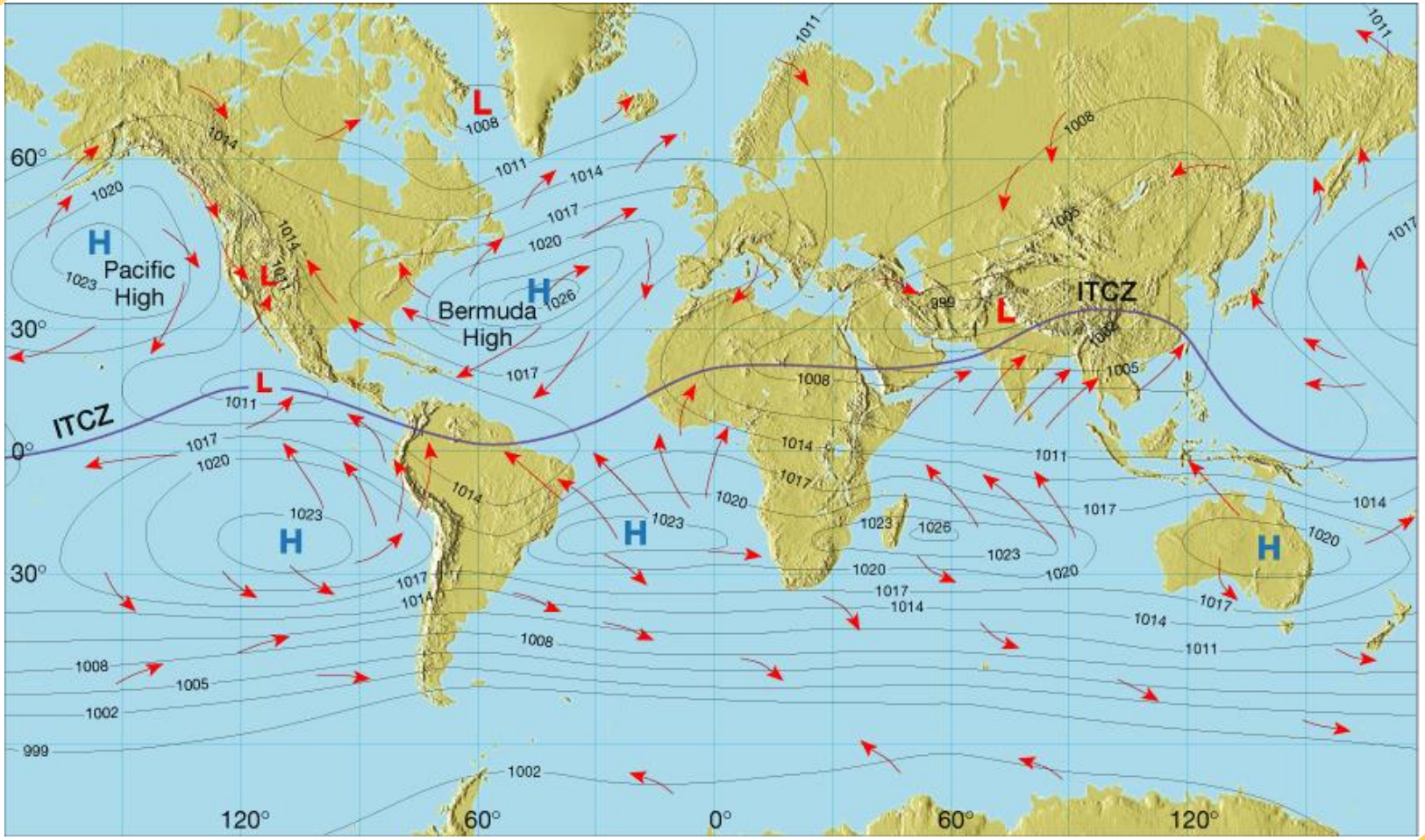


19.2 Pressure Centers and Winds

Global Winds

- Influence of Continents
  - The only truly continuous pressure belt is the subpolar low in the Southern Hemisphere. In the Northern Hemisphere, where land masses break up the ocean surface, large seasonal temperature differences disrupt the pressure pattern.
  - **Monsoons** are the seasonal reversal of wind direction associated with large continents, especially Asia. In winter, the wind blows from land to sea. In summer, the wind blows from sea to land.

Surface Pressure

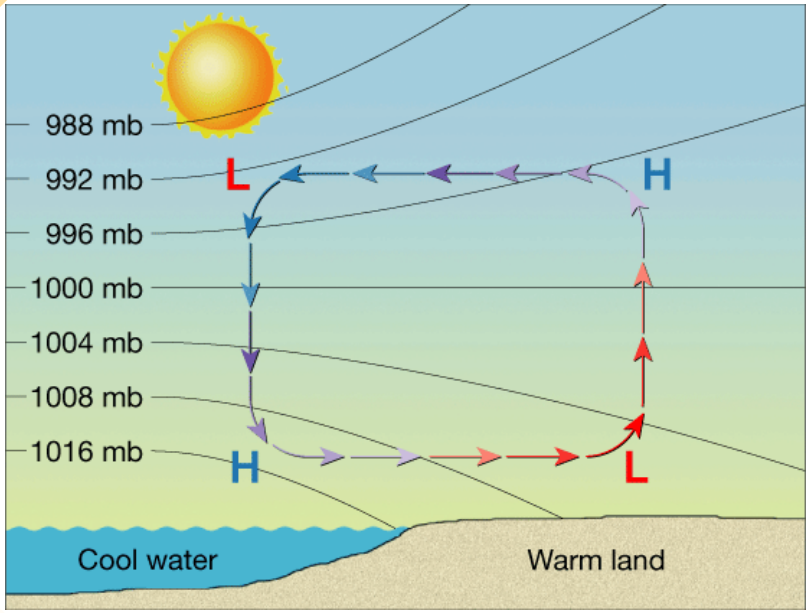


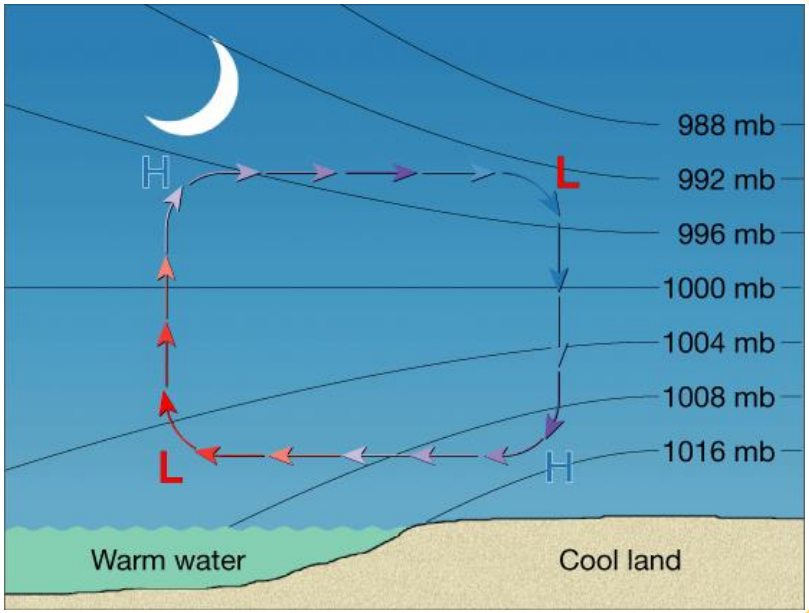
19.3 Regional Wind Systems

Local Winds

- The local winds are caused either by topographic effects or by variations in surface composition—land and water—in the immediate area.
- Land and Sea Breezes
  - In coastal areas during the warm summer months, the land surface is heated more intensely during the daylight hours than an adjacent body of water is heated. As a result, the air above the land surface heats, expands, and rises, creating an area of lower pressure. At night the reverse takes place.

Sea and Land Breezes



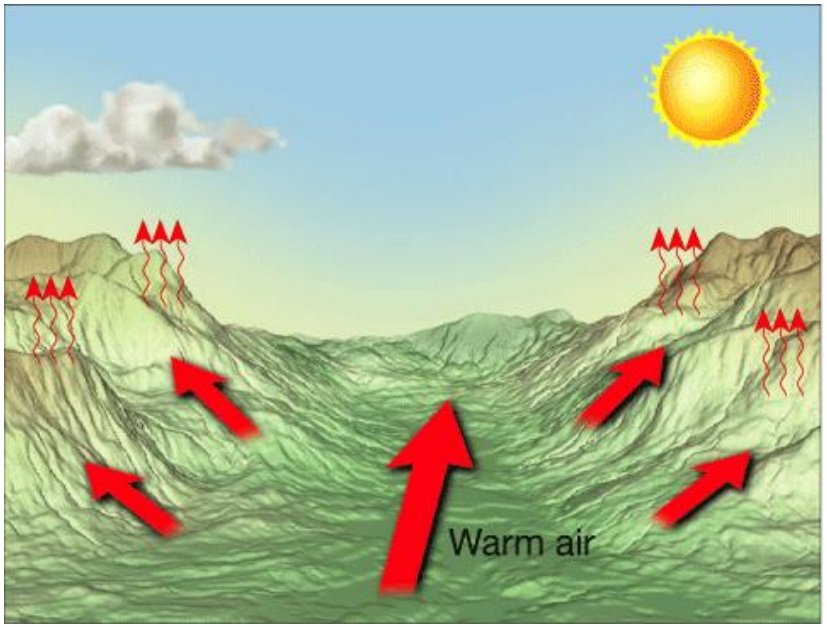


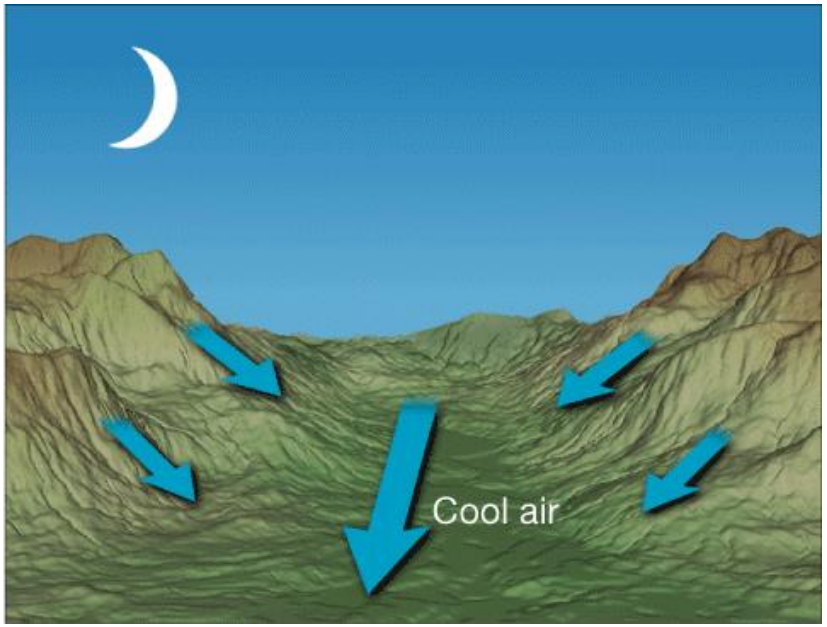
19.3 Regional Wind Systems

Local Winds

- Valley and Mountain Breezes
  - In mountainous regions during daylight hours, the air along the slopes of the mountains is heated more intensely than the air at the same elevation over the valley floor. Because this warmer air on the mountain slopes is less dense, it glides up along the slope and generates a valley breeze. After sunset the pattern may reverse.

Valley and Mountain Breezes





19.3 Regional Wind Systems

How Wind Is Measured

- Wind Direction
  - The **prevailing wind** is the wind that blows more often from one direction than from any other.
  - In the United States, the westerlies consistently move weather from west to east across the continent.

19.3 Regional Wind Systems

How Wind Is Measured

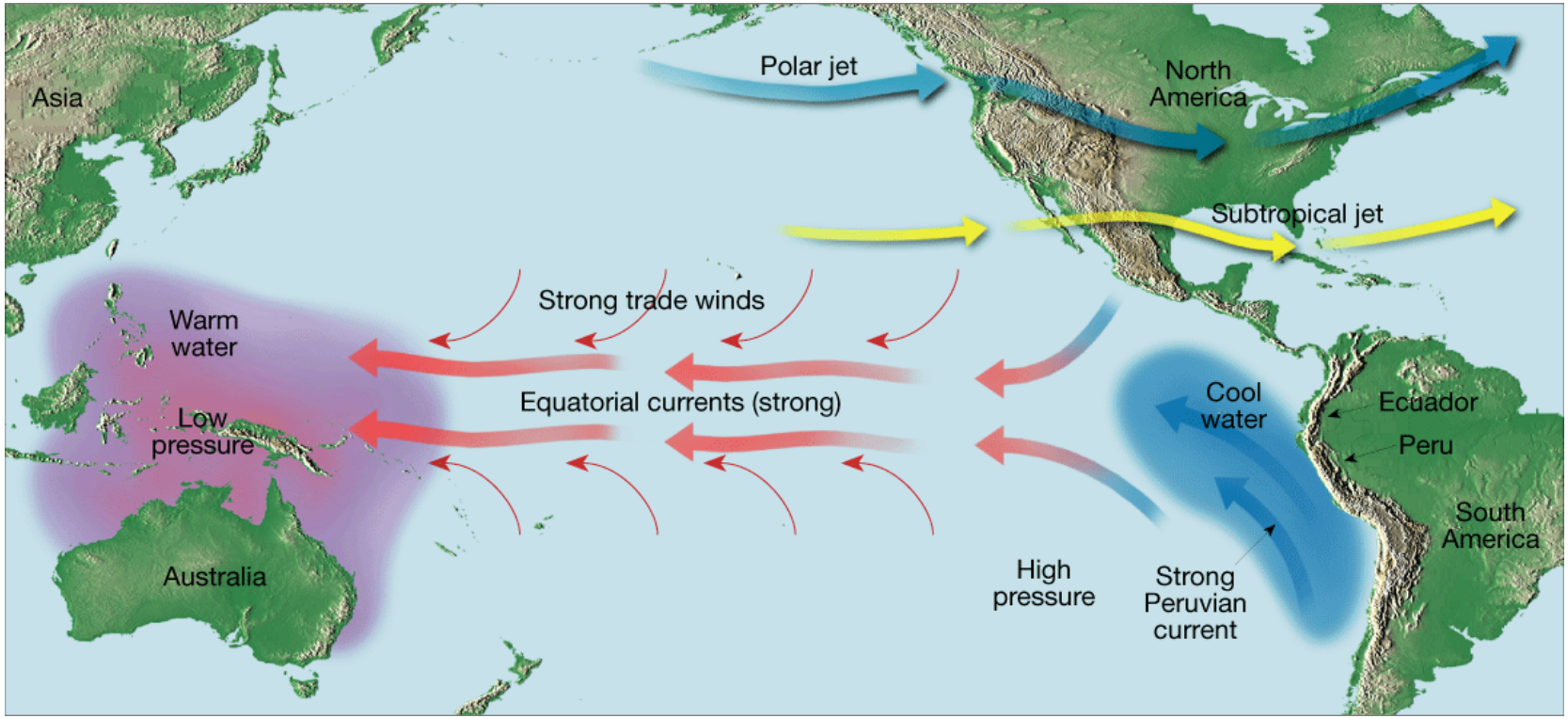
- Wind Speed
  - An **anemometer** is an instrument that resembles a cup and is commonly used to measure wind speed.

19.3 Regional Wind Systems

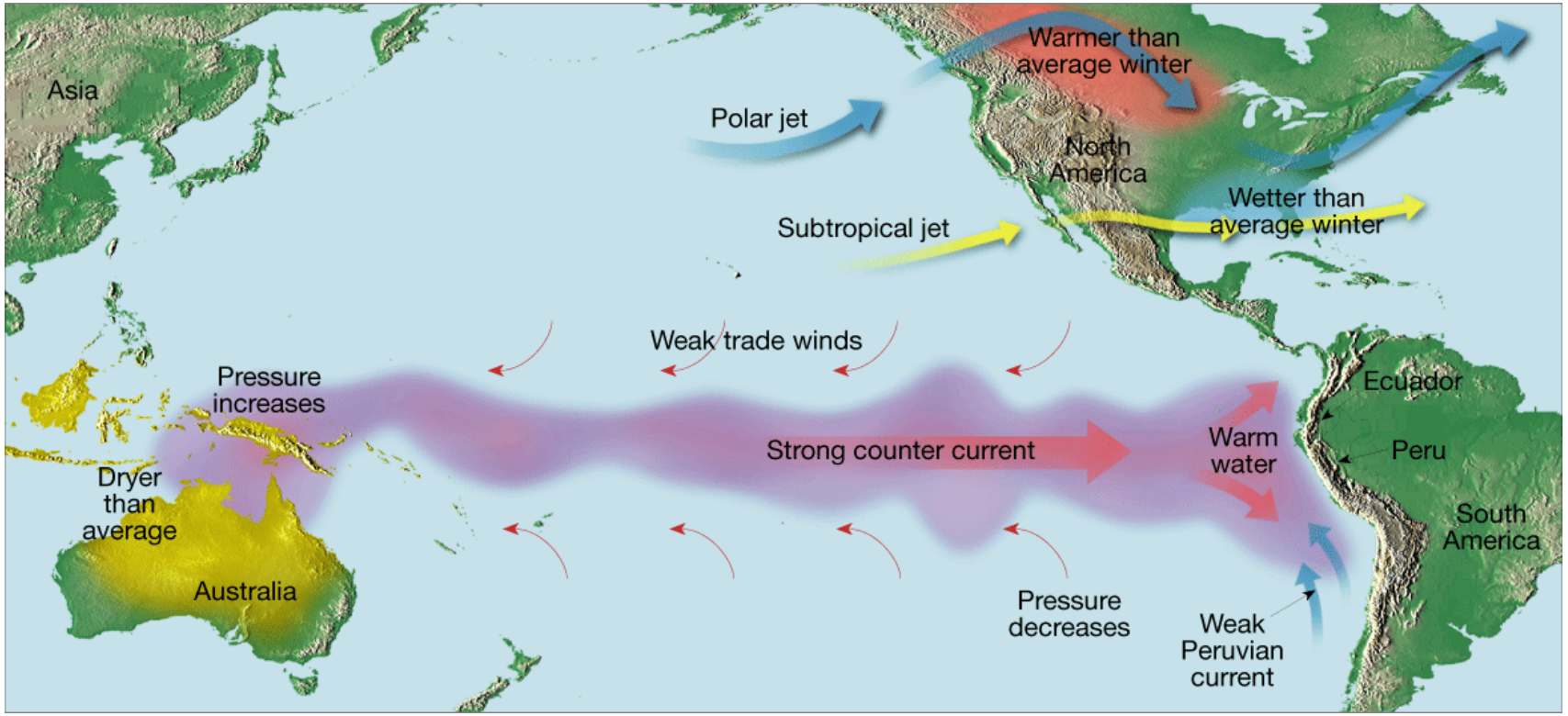
El Niño and La Niña

- El Niño
  - **El Niño** is the name given to the periodic warming of the ocean that occurs in the central and eastern Pacific.
  - At irregular intervals of three to seven years, these warm countercurrents become unusually strong and replace normally cold offshore waters with warm equatorial waters.
  - A major El Niño episode can cause extreme weather in many parts of the world.

Normal Conditions



El Niño Conditions



19.3 Regional Wind Systems

El Niño and La Niña

- La Niña
  - Researchers have come to recognize that when surface temperatures in the eastern Pacific are colder than average, a La Niña event is triggered that has a distinctive set of weather patterns.

19.3 Regional Wind Systems

Global Distribution of Precipitation

- Global precipitation can be explained if knowledge of global winds and pressure systems are applied.